VFT, Probabilistic Reasoning, and Supercomputers for Space Mission Design

Ralph F. Miles

The power of supercomputers now makes it possible to bring together Value Focused Thinking (VFT) and probabilistic reasoning in simulation modeling for Space Mission Design. Both the mission environment (space trajectories, and the surfaces of planets, asteroids and comets) and the mission systems (launch vehicles, spacecraft, landers, rovers, and mission operations) can be simulated with probabilistic reasoning and sufficient validity to support major space mission decisions. A Value-Focused-Thinking approach to modeling multiattribute decision criteria incorporating risk aversion will be integrated with performance and resource parameters determined probabilistically for systems and environmental models. The supercomputer hardware, software, communication, and visualization capabilities of the Jet Propulsion Laboratory Advanced Development Laboratory will be described. Results will be shown for Mars rovers using the autonomous flight software of the Mars Pathfinder Sojourner Rover on a simulated but statistically valid Mars terrain. Statistics derived for future rover hardware and software navigation algorithms will be used to identify optimal rover systems for the future Mars Exploration Program. Descriptions will also be presented for simulations of autonomously-guided descent through the Martian atmosphere with obstacle-avoidance hardware and software algorithms to targeted landing sites on rocky terrain.